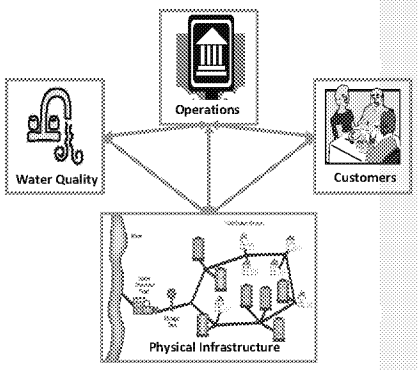
ORD Research & Development: EPANET Water Distribution System Software

EPA's Role

- EPA provides technical assistance to US drinking water utilities
  - More than 50,000 DW systems
  - Regulatory implementation, treatment technology, distribution system issues, infrastructure protection
  - DBP's, nitrification, emerging contaminants, low disinfectant residuals, aging infrastructure, oversized infrastructure, emergencies and natural disasters, physical & cyber security
- EPA conducts R&D as required by statutes & presidential directives
  - Safe Drinking Water Act & Amendments
  - BioTerrorism Act of 2002
  - Critical Infrastructure Protection Directives

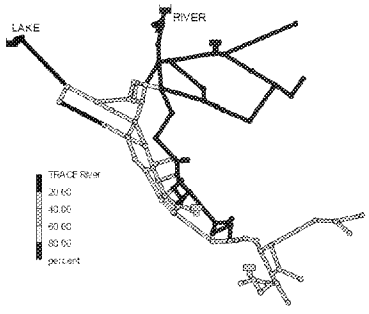
Systems Approach

- Systems problems require systems solutions
  - Hydraulic and water quality modeling a critical tool to address these problems
  - Modeling enables systems understanding
  - Beneficial to solve problems of the future



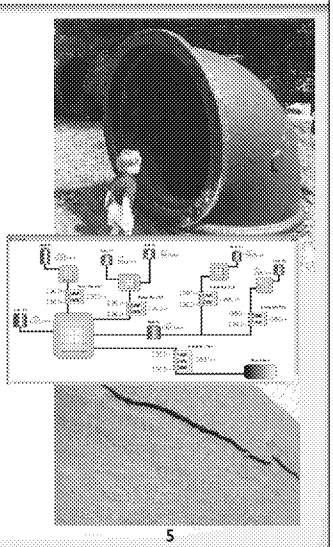
EPANET Software

- Models and simulates hydraulics within water distribution network
- Models and simulates simple decay/growth of a single substance
- Developed in 1990 by Lew Rossman
- Executable and Programmer's Toolkit
- Latest official release: 2.00.12 in 2008
- More than 60,000 downloads per year
- Components utilized for multiple commercial software packages



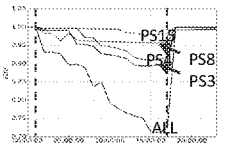
EPANET User Applications (I)

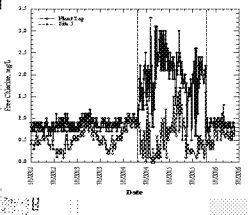
- Planning for the Future
  - Sizing/locating new pipes & facilities, increasing/decreasing future demands, evaluating supplies, building resilience
- Replacing Aging Infrastructure
  - Main breaks, leaks and water loss, damaged infrastructure, prioritization/staging of repairs
- Optimizing Operations
  - Pump schedules, tank cycling, pressure management, energy reduction

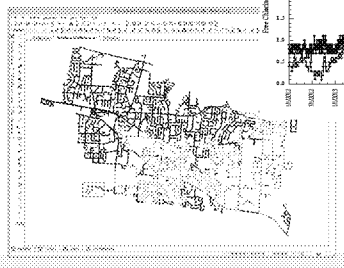


EPANET User Applications (2)

- Solving Water Quality Problems
  - Customer complaints, low chlorine residuals, high water age, disinfection byproducts
- Preparing for Emergencies
  - Power outages, fires, source water spills, natural disasters, cyber attacks
- Real-time operations and decision-making
  - Integrating SCADA data, supporting rapid decisions

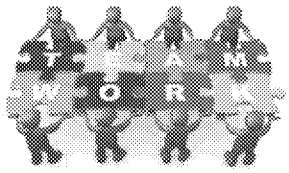






EPANET Stakeholders

- Water utilities (including small and international systems)
- ASCE/EWRI Water Distribution Systems Analysis (WDSA) Committee
- AWWA Engineering Modeling & Applications (EMAC) Committee
- Software companies (e.g., Bentley, Innovyze, KYPipe)
- Consultants
- Researchers (and students)
- Open Source EPANET Initiative
- National Center for Infrastructure Modeling and Management (NCIMM)



Open EPANET Initiative

- ASCE/EWRI Standing Committee on Water Distributions Systems Research (WDSA) voted to initiate an "Open Source EPANET Initiative" in May 2015
- Steering Committee (NCIMM, Universities in US, UK, Columbia, Australia, South Africa)
- Development Committee (CitiLogics, University of Cyprus, OptiWater-Israel, USEPA, others)
- Discussion Forum
- C++, object oriented, GitHub repository, automated testing
- EPANET 2.00.12 provided the foundation for OWA's 2.1 and 2.2
- Lew Rossman shared EPANET 3.0 code

EPANET Research & Application Areas

- EPANET Multi-Species Extension and Fate & Transport Research
- Sensor Placement & Consequence Assessment Tool
- Water Security Toolkit for Response & Recovery
- Water Network Tool for Resilience
- EPANET Real-time Extension & RTX:LINK
- EPANET User Interface
- EPANET Open Source Development Project

Open Source Development Project

- Research project underway to investigate open source development for EPANET
  - QA/QC plans (best software practices, testing, bug fixes, code documentation, Github)
  - Contributor guidance (how to contribute code to EPANET)
  - Licensing and waivers
  - Planning for new official release of EPANET
  - Longer term planning for 3.0 release
  - EWRI EPANET Summit, April 2018 Reston VA
  - Session at EWRI/WDSA in Minneapolis - June 2018
  - Session at WDSA/CCWI in Kingston, Canada – July 2018

EPA's Role in Open Source

Acting as central consolidator for official EPA version:

- Coordinating official software releases
  - Developing software roadmap
  - Setting release schedule
  - Accepting contributions
  - Posting official releases to EPA website
- Ensuring QA/QC
  - New QA plan & testing framework
- Communicating draft contributor guidelines
- Contributing to software development
- Collaborating with development partners
- Monthly teleconferences with interested parties

EPA's Next Steps

- EPA Official release of EPANET 2.2 by end of 2018
  - Incorporating:
    - OWA versions 2.1 & 2.2
    - Bug fixes
    - 6 near term items identified at Summit
    - Updated online User Manual (read the docs)
    - Updated Delphi 10 interface
    - Automated testing
  - Monthly meetings with community
  - https://github.com/USEPA/Water-Distribution-Network-Model
- New user interface
  - Bug fixes ongoing
  - Identifying additional features
  - https://github.com/USEPA/SWMM-EPANET_User_Interface

Moving Forward

- Continued communication with stakeholder community to plan future of EPANET
- Champion systems modeling approach to problem solving
- Collaborate on software development & best practices (testing, documentation, etc.)
  - NCIMM support to help improve the software testing framework (Bob Dickinson's help)
  - NCIMM supporting EPANET training
- Continued support for R&D / case study applications
  - Research planning process underway